

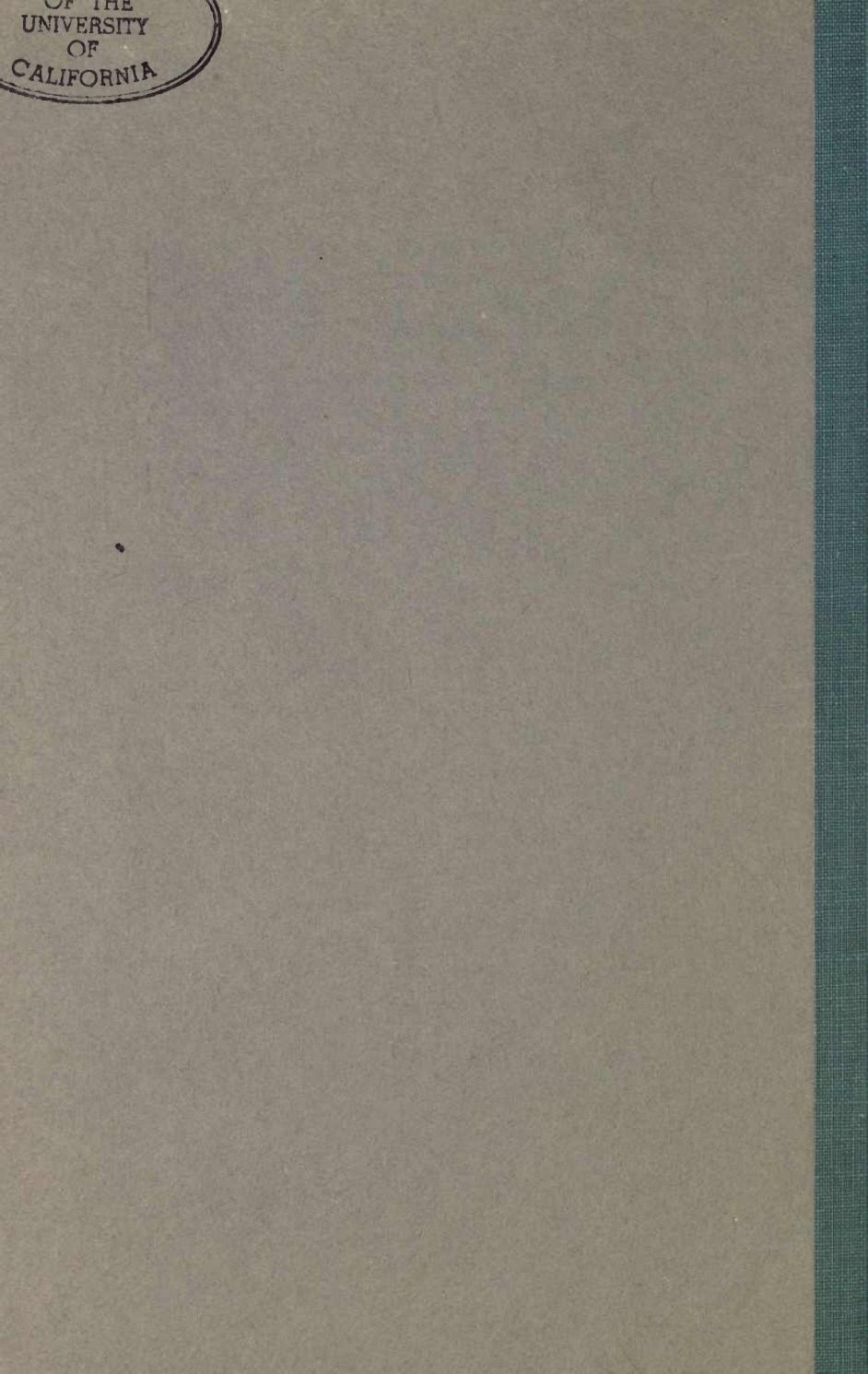
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SUDAN GOVERNMENT

Wellcome Tropical Research Laboratories,

Khartoum

Papyrus and Paper Manufacture

BY

William Beam M. D., F. I. C.

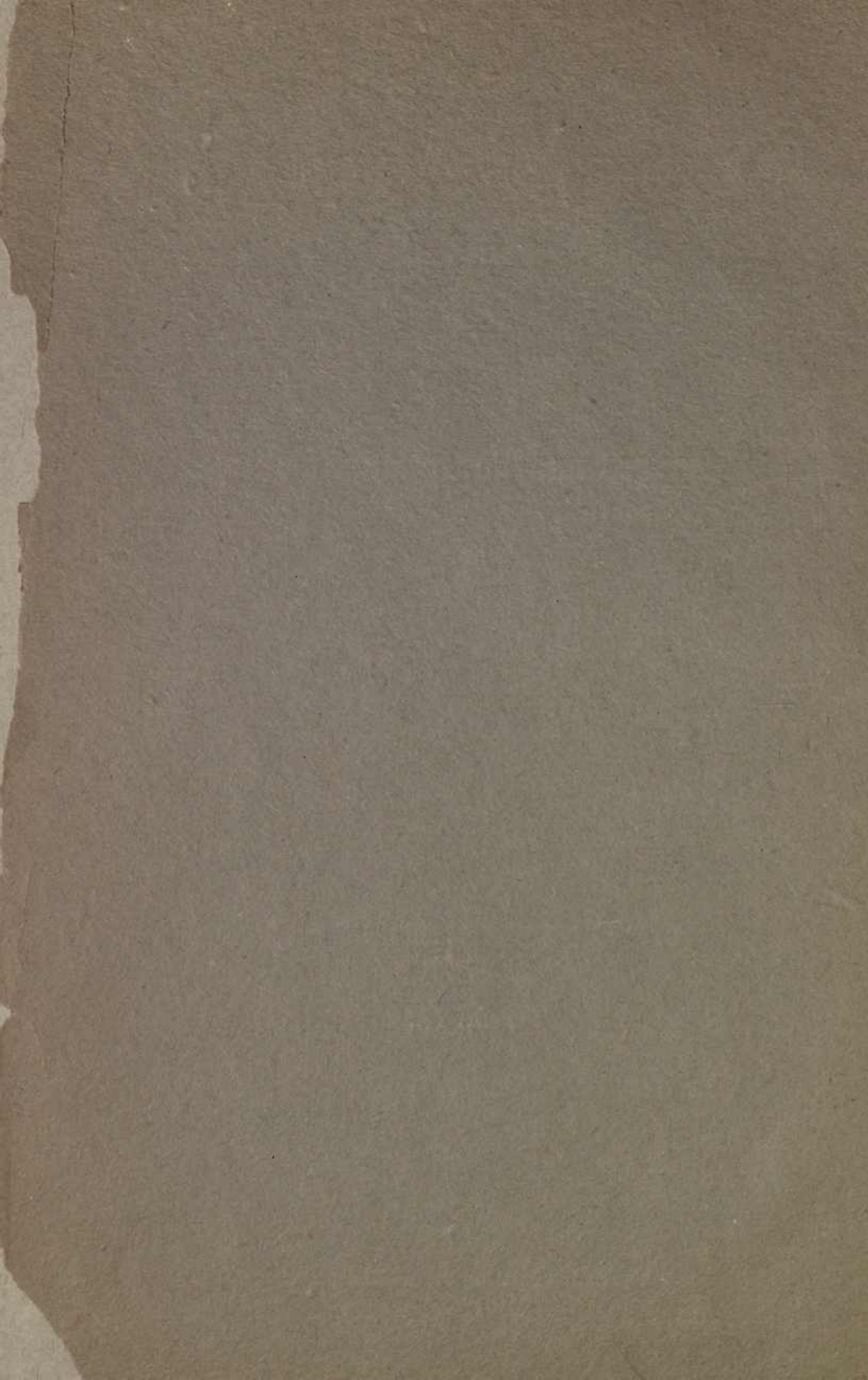
Research Chemist

CHEMICAL SECTION BULLETIN No. 2

March, 1915



The Sudan Printing Press—Khartoum



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PAPYRUS AND PAPER MANUFACTURE

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The reed known as papyrus, *Cyperus papyrus*, was, as is well known, the source of one of the earliest forms of paper. The process of manufacture was quite simple. The outer fibrous layers of the stem were separated by means of a sharp tool and the strips so secured were spread out parallel to each other on a flat surface, moistened with a little gum water and covered with similar material laid cross-wise. After pressing and drying the sheets were polished by rubbing with a smooth piece of stone or ivory.

In recent years papyrus has attracted considerable attention as a possible source of paper by modern methods of production. The success of such an undertaking is dependant upon a number of factors, chief among which are the extent of the supply of raw material, the cost of its collection and transport to the point of manufacture and the quality of the paper produced.

Supply of raw material. In forming an opinion as to the sufficiency of supply of any new material for paper making, it is fully realized that very large quantities are required by even a single mill of average capacity and that once a given material has been adopted for the purpose, the supply must be maintained without break or check.

In the Sudan, papyrus is found in isolated patches at various points on the White Nile south of Khartoum. These patches are derived from the small islands of "sudd" detached from the main growth in the Upper Nile and carried down by the current, especially during the season of flood. As one proceeds south it begins to be found in much greater quantity a short distance below Lake No, about 986 kilometres from Khartoum. From this point it extends south on the Bahr el Gebel to Abu Kika, about 1496 kilometres from Khartoum and covers in many places an area of a kilometre or more in width on one or both sides of the river.

When it is realized that even though the whole of this enormous amount of material were collected it would be entirely renewed at the end of a year, there appears to be little danger of failure of any paper-making enterprise due to lack of raw material. It is true that, especially towards the end of the dry season, a certain amount is annually destroyed by fires; but once the work of collection is seriously undertaken, this loss could be minimized by taking the precaution to make the earlier cuttings in such a way that the denuded areas serve as fire lines and thus afford at least some measure of protection to the remainder.

The quality of the paper produced. The experimental production of crude and bleached pulp was carried out in this laboratory in 1908. As far as could be determined by trials on a small scale the results appeared promising. The yield of crude pulp obtained, calculated on the dry stems, was approximately 33 per cent, and a noteworthy feature was the ease with which this was bleached by hypochlorite. A sample of the stalks sent to the Imperial Institute for comparison with esparto grass was reported on to the same effect, and the dried stems were valued at about £3 per ton, delivered in England. Trials on a more complete and larger scale were carried out for the "Sudd Fuel (Suddite)" Company by Messrs Tulliss, Russell and Co., and by Messrs Thomas and Green, under the auspices of Messrs Cross and Bevan. These indicated on the whole a valuation about equal to esparto and special very promising features were noted. It was found *e.g.* that the pulp could be used as an "entire furnish" *i.e.* without admixture of wood or other long fibre. The colour was also approximately up to the standard of ordinary bleached supply. These and other results "establish very important points of all round utility as a paper-making fibre, combining many of the advantages of esparto, wood and rag; and the fibre would work in, in all grades of paper, as a useful auxiliary in any case. It has also been shown by results that the *entire paper* is of satisfactory quality and when fully studied as an entire furnish will give some rather exceptional qualities of paper."

From the earliest results of investigations of this subject in these laboratories, it was evident that the success of any venture in the direction of the commercial utilization of papyrus for paper making,

was dependant upon the ability to lessen the cost of transport by manufacturing, in the Sudan, and preferably in the sudd region, some form of concentrated material or "half-stuff." This view has received support from the reports of the Imperial Institute and of Messrs. Cross and Bevan, in both of which attention is called to the desirability of directing the operations in the Sudan to that end. As already noted the raw material in the shape of air dried stalks is valued at about £3 per ton at which figure profitable exportation would hardly be possible.

In their report, referred to above, Messrs Cross and Bevan have suggested the possibility of appreciating the yield of paper-making fibre by crushing the freshly cut reeds in order to separate the juice and possibly, also, a certain amount of the useless cellular matter. This however had already been tried with little success. A more promising method appeared to be by steeping in water, with or without access of air. It was hoped that by such a process of "retting," the plant might be so broken down as to permit of the removal of the whole or greater part of the cellular matter by mechanical treatment. Very many trials were made, in some cases with addition of ferments, but the only portion of the plant which yielded to the treatment was that quite close to the base of the stalk—the first six or eight inches. In some of the experiments the plants were submerged for more than two months without appreciable effect. These results were in keeping with the observations made on stalks found floating, in a decomposed state, in the river. In no case was there any evidence of selective action, the plant yielding to the fermentative processes more or less as a whole.

The production of crude pulp or half-stuff was next attempted by simple, open, boiling with caustic soda. Using the fresh, green, material it was found that, except in the case of young plants, this could be effected only with difficulty, the lower more dense portion of the stems being very resistant. Much better results were had by operating on the previously dried material, obviously for the reason that penetration by the caustic liquor was more rapid and complete. Two hours boiling sufficed for complete disintegration in this case, whereas the lower portions of the green stems were still practically unaffected after eight to ten hours treatment, in the same strength of caustic liquor. Experiments in this direction have however been

suspended as unpromising under present conditions. The great cost of caustic soda in so remote a region and the lack of suitable limestone in the neighbourhood for its revivification, makes its application desirable only as a last resort. A method of manufacturing the concentrated material without the use of chemicals is obviously what is required, and a number of experiments in this direction resulted in the development of the following procedure which gives good results on the small scale and appears capable of application on a manufacturing one by the use of suitable mechanical contrivances.

If the papyrus stems, either green or dry, be treated with water under pressure to a temperature of from 142°C to 150°C for from three to six hours, and then removed and beaten in a stream of water, practically the whole of the soluble and cellular matter may be removed, the fibrovascular bundles chiefly remaining. The fibre so obtained is darker in proportion as the digestion has been carried out at a higher temperature, but even the darkest specimens have yielded a perfectly white pulp on subsequent treatment with caustic soda and bleach in the usual manner.

The advantages of a method of this kind are very great. Not only are no chemicals required but there are no difficulties as regards the disposal of waste products, a serious matter when working on the large scale which is essential to the success of any project of this nature.

The following yields were had, the material employed being the air-dried stems containing, roughly, 8 per cent of moisture.

- (a) Digested at 142°C for 6 hours.

Yield of dry half-stuff = 40.5 per cent.

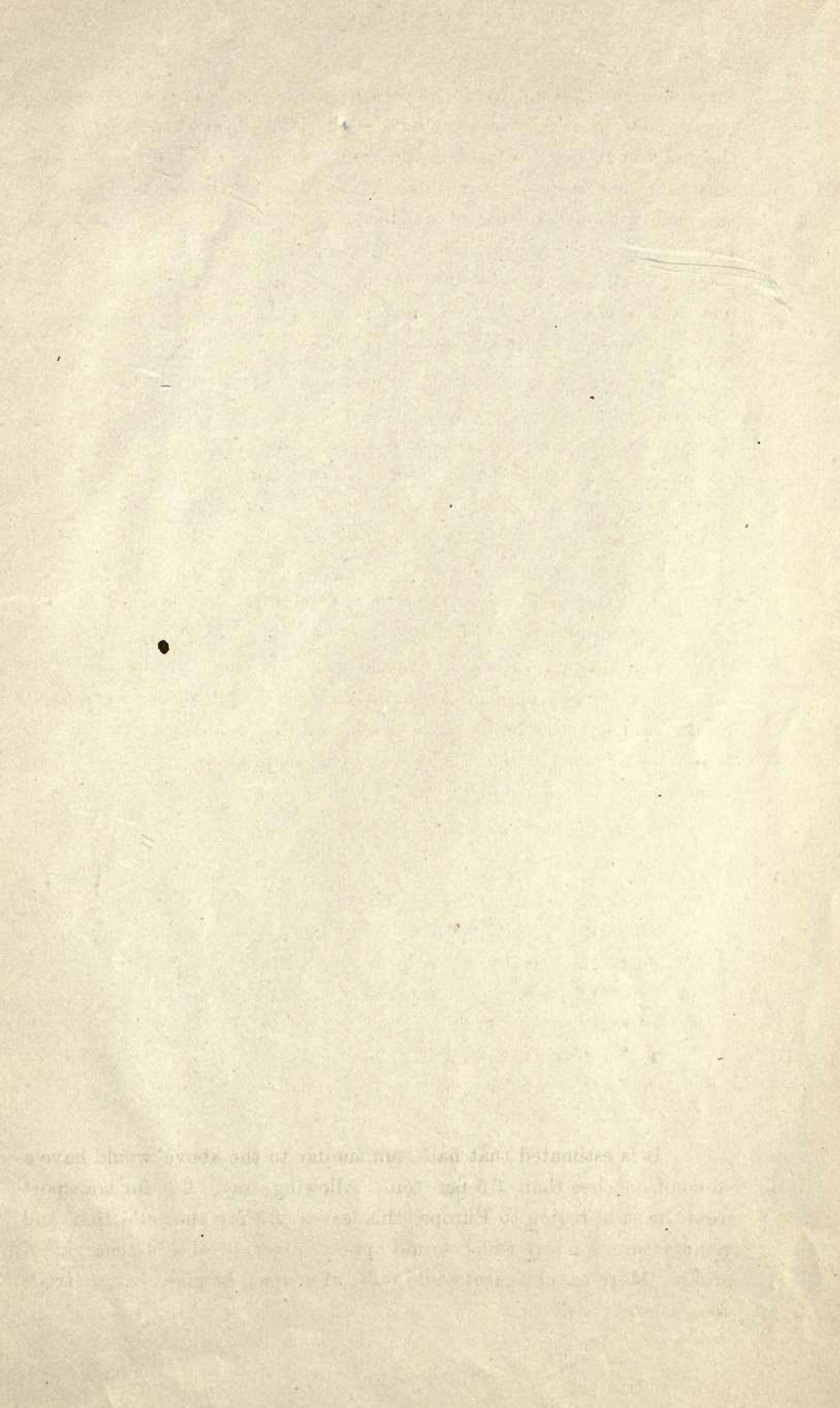
On further treatment with caustic soda and bleach this yielded 55.2 per cent of bleached pulp.

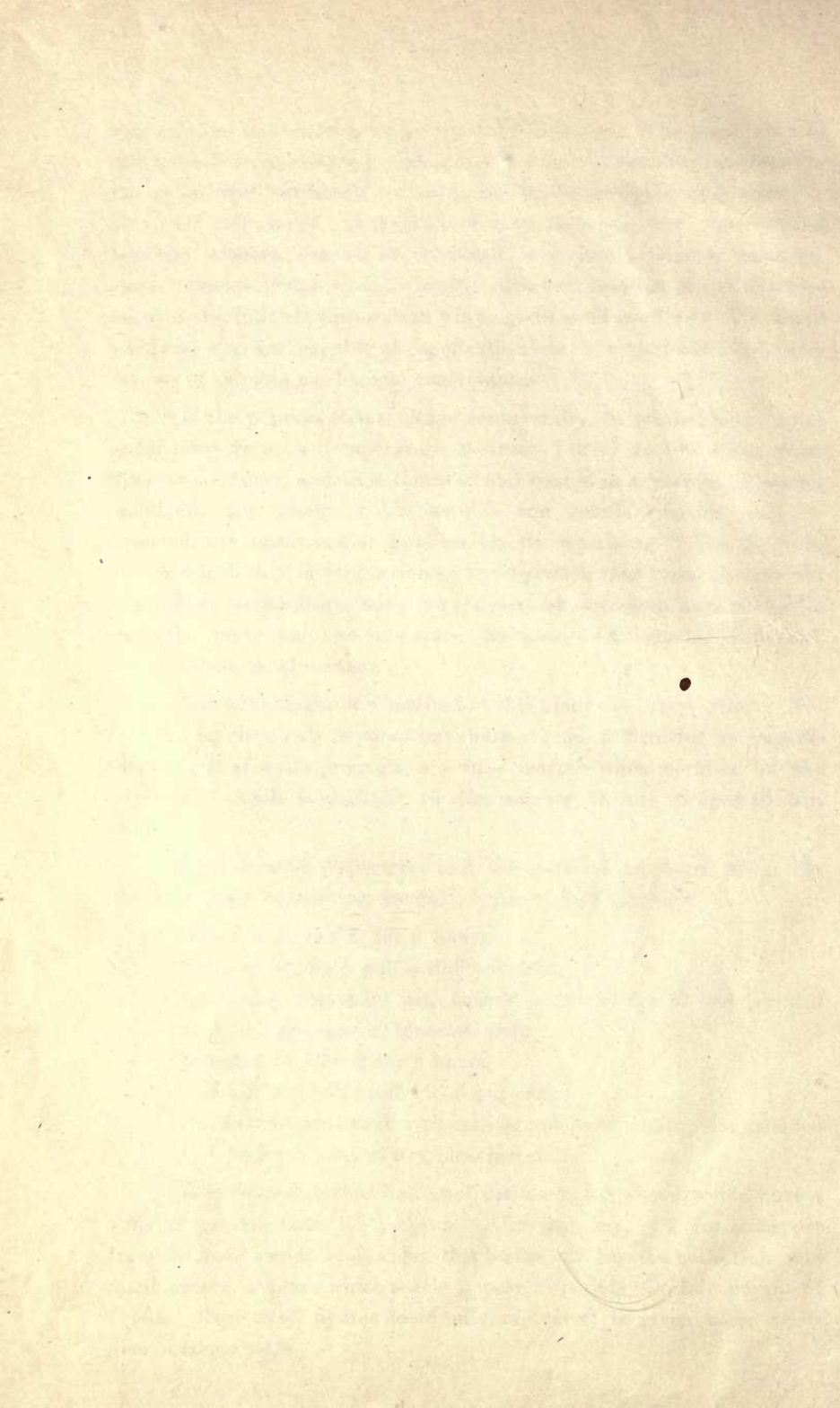
- (b) Digested at 150°C for 3 hours.

Yield of dry half-stuff = 37.5 per cent.

On further treatment with caustic soda and bleach, this yielded 54.8 per cent of dry bleached pulp.

It is estimated that half-stuff similar to the above would have a value of not less than £5 per ton. Allowing, say, £2 for transport from the sudd region to Europe, this leaves £3 for the collection and manufacture, a figure which would appear to permit of a fair margin of profit. More exact figures could only, of course, be given after trials upon a larger scale.





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